

**Kertas Asli/Original Articles****Lip Prints in Sex and Race Determination**  
(Cap Bibir dalam Penentuan Jantina dan Bangsa)NEO XIAO XU, KHAIRUL OSMAN, SRI PAWITA ALBAKRI AMIR HAMZAH,  
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## ABSTRACT

*Individual identification is an important and challenging task in forensic investigation. Lip print on drinking glass or cigarette butt found at crime scenes may link to a suspect. The aim of this study was to determine the differences in lip print between sexes or races, differences in lip measurement between sexes or races and determine a way to estimate sex and race by using lip print or lip measurements for main races in Malaysia. A total of 134 subjects (67 males and 67 females) of Malay, Chinese and India were recruited from Universiti Kebangsaan Malaysia Campus Kuala Lumpur (UKMUKL), Malaysia. Lip prints were taken by using a lipstick and a transparent cellophane tape. Lip measurements were taken by using electronic digital callipers. Lip prints were classified according to Tsuchihashi classification. Statistical analysis indicated that there was a significant difference in lip print between sexes ( $p < 0.001$ ) but not in races ( $p > 0.05$ ). Width of oral opening and the height of lower lip both indicated significant differences between sexes ( $p < 0.001$ ) while the height of upper lip and lower lip each indicated significant differences between races ( $p < 0.05$ ). However, there was no significant interaction between sexes and races for all lip measurements. Formulae for sex and race determination were calculated with Classification Tree when there was significant difference between every comparison. Tables of accuracy percentage and performance evaluation for method in categorizing sex or race by using lip print or lip measurement were made. For validation of method in sex determination based on the formulae formed, accuracy in females is 90% and 65% in males. Therefore, overall percentage of accuracy in sex determination was 77.5%. This study can provide a preliminary idea about the use of lip prints in sex or race determination among Malaysian population.*

**Keywords:** Lip print, cheiloscopy, Tsuchihashi classification, sex determination, race determination

## ABSTRAK

*Identifikasi individu merupakan perkara yang penting dan mencabar dalam penyiasatan forensik. Cap bibir pada gelas minuman dan puntung rokok di tempat kejadian jenayah menyediakan hubungan langsung terhadap suspek. Kajian ini dijalankan untuk menentukan sama ada terdapat perbezaan yang signifikan pada cap bibir antara jantina atau bangsa, ukuran bibir antara jantina atau bangsa dan membentuk formula demi mengangkar jantina dan bangsa dengan menggunakan cap bibir atau ukuran bibir bagi bangsa utama di Malaysia. Seramai 134 orang subjek (67 lelaki dan 67 perempuan) yang terdiri daripada bangsa Melayu, Cina dan India diambil dari Universiti Kebangsaan Malaysia Kampus Kuala Lumpur (UKMUKL), Malaysia. Cap bibir diambil dengan menggunakan gincu merah dan pita selofan lutsinar manakala ukuran bibir diambil dengan menggunakan angkum cara mengukur. Cap bibir dikelaskan dengan menggunakan klasifikasi Tsuchihashi. Hasil statistik menunjukkan cap bibir mempunyai perbezaan yang signifikan antara jantina ( $p < 0.001$ ) manakala tidak pada bangsa ( $p > 0.05$ ). Dari segi ukuran bibir, didapati panjang bibir dan ketebalan bibir bawah menunjukkan perbezaan yang signifikan ( $p < 0.001$ ) antara jantina manakala ketebalan bibir atas dan ketebalan bibir bawah pula mempunyai perbezaan yang signifikan antara bangsa ( $p < 0.05$ ). Namun, tiada perbezaan yang signifikan bagi interaksi antara jantina dan bangsa terhadap ketiga-tiga ukuran bibir. Formula penentuan jantina dan bangsa telah dibentuk dengan Classification Tree apabila terdapat perbezaan yang signifikan antara setiap perbandingan yang dibuat. Jadual ketepatan dibuat untuk menunjukkan peratus ketepatan dan evaluasi prestasi bagi kaedah pengkategorian jantina atau bangsa dengan menggunakan cap bibir atau ukuran bibir. Dalam validasi kaedah penentuan jantina dengan menggunakan cap bibir yang dibuat secara manual, didapati ketepatan bagi perempuan adalah sebanyak 90% dan 65% pada lelaki. Oleh itu, ketepatan penentuan jantina secara manual adalah sebanyak 77.5%. Kajian ini dapat memberi idea awal tentang kegunaan cap bibir dalam penentuan jantina atau bangsa seseorang dalam populasi Malaysia.*

**Kata kunci:** Cap bibir, cheiloscopy, klasifikasi Tsuchihashi, penentuan jantina, penentuan bangsa

## INTRODUCTION

Lip print is unique for individuals (Saraswathi et al. 2009). It does not change during the life of a person. However, major trauma to the lips may lead to scarring and thus altering the pattern and morphology of grooves. The study of lip prints is termed as 'cheiloscopy' and the variations in lip print patterns among males and females could help in sex determination (Gondivkar et al. 2009). Besides, previous researchers performed on the subject revealed that lip prints did show differences according to the race and ethnic origins of a person (Verghese et al. 2010). Petersen (2009) stated that lip prints of identical twins are not exactly identical and thus is unique.

Identification of unknown victim or suspect will always be a challenging task in forensic crime cases. Sometimes, it is necessary to apply lesser known and unusual techniques like cheiloscopy (Sharma et al. 2009). Besides, Sharma et al. (2009) also indicated that lip print is very useful in forensic investigation as well as in personal identification and they are considered to be the most important forms of transfer evidence, analogous to fingerprints. It is because lip print may be found on drinking glass and the cigarette, no matter it is visible or not. Those latent or invisible lip prints can be detected using aluminium powder and magnet powder as mentioned by Sharma et al. (2009).

Lip prints form changes according to various causes of death (Utsuno et al. 2005), making lip prints a weak tool in identifying the person that had died for a period of time. According to Utsuno et al. (2005), clear and identifiable lip prints can be obtained when it is taken less than 24 hours following death. A lip print is different in every living individual and does not change with time therefore it can be used as a method of identification (Bindal et al. 2009). Thus, cheiloscopy is applicable mostly in identifying living, since lip prints are usually left at crime scenes and provide a direct link to the suspect. In addition, cheiloscopy is a simple technique that does not require any complex instrumentations (Sharma et al. 2009). Thus, the

identification and comparison of lip prints are easier to be conducted.

Malaysia, with a diverse culture has three major races, Malay, Chinese, and India. Minor group include Iban, Dayak and Kadazan. The present population of Malaysia comprises of 67.0% Malay, 24.3% Chinese, 7.4% Indian and 1.3% other minority groups (Jabatan Perangkaan Malaysia 2010). The estimation method developed for lip prints only can be used for Malaysian population as this study is carried out in Malaysia. It is hope that this study will contribute some guide in indentifying unknown lip prints present at crime scenes in Malaysia.

The aim of the present study was to determine whether there are any differences in lip prints or lip measurement between sexes or races.

## MATERIAL AND METHOD

This study was conducted among students age 20-26 years in Universiti Kebangsaan Malaysia Kuala Lumpur Campus, Malaysia. According to the Prevalence Sample Size Calculator (Naing et al. 2006), the suggested sample size was 134 with a prevalence of 0.0964, as per previous protocol by Gondivkar et al. (2009). The 134 subjects, consisted of 44 males and 44 females Malay, 18 males and 18 females Chinese and Indian 5 males and 5 females based on the ratio of population in Malaysia. Individuals who were hypersensitive to lipstick, having defects or scars on lips, underwent lip surgery before, dried or chapped lips and those who were not from UKM KKL were excluded from this study.

Figure 1 showed the anatomy of the lips (Utsuno et al. 2005). Width of oral opening was measured from right cheilion to left cheilion. Height of the upper lips was taken from labrale superior to stomion and height of the lower lips was taken from stomion to labrale inferior. The subjects' lip measurements were first taken directly using electronic digital caliper prior to applying the lipstick on their lips. Each measurement was repeated three times. Then, subjects

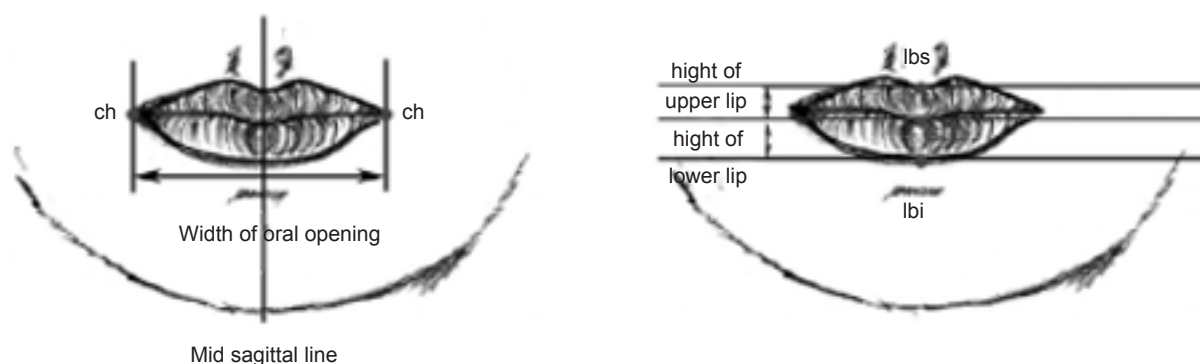


FIGURE 1. Anatomy of the lips

were required to clean their lips with tissues. Lipstick was evenly applied on their lips, single stroke with the lipstick brush. Each subjects used different lipstick brush. Lip impression was made by using a strip of cellophane tape. The cellophane tape was stick on the subject's lip where the lipstick was applied. Adequate pressure was put on every part of the lip. It was then removed from subject's lip carefully and stick on a white A4 size paper. Three lip prints from each subject were taken without reapplying the lipstick. Then, 40 lip print samples were used to validate the method to determine the sex of lip print. The same type and colour of lipstick was used in both male and female subjects. The lipstick used was less greasy to avoid smudging on lip prints. Lipstick chosen was red and non-glossy for optimum print visibility (Verghese 2005). The cellophane tape used was transparent and stick on one side. The width was 45 mm which was adequate to contain the whole lip print.

The lip prints were classified based on the Classification Tsuchihashi (Table 1 and Figure 2). The data collected were analyzed by statistical test using Statistical Package Social Sciences (SPSS) for Windows version 18.0. Chi-square test for independence was conducted to determine whether there were significant differences in lip prints between sexes or races. Independent t-test was performed to determine the differences in each lip measurement between sexes. One-way between groups ANOVA was used to determine the differences in each lip measurement between three races. To determine the interaction effect between sex and race, a two-way repeated measures ANOVA was used. Classification and regression tree was used to categorize the lip print pattern or lip measurements into sex or race.

TABLE 1. Tsuchihashi classification

	Groove type
Type I	Complete vertical
Type I'	Incomplete vertical
Type II	Branched
Type III	Intersected
Type IV	Reticular pattern
Type V	Irregular

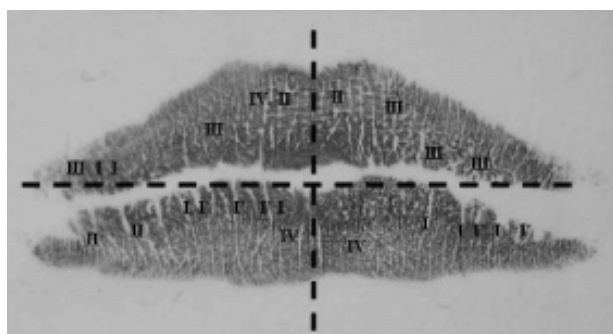


FIGURE 2. Tsuchihashi classification

To validate the method in individualizing the sex and race for lip prints accuracy, table with percentage was made.

The lip prints were divided into four quadrants for analysis (Figure 2). Every groove was identified, noted, counted and each lip print was grouped according to the most dominant pattern of groove.

## RESULT

Table 2 showed the most predominant pattern in all the male subjects was Type III followed by I, I', II, IV and V while for females the most predominant pattern was Type I and I', followed by III, IV and V. No female subjects had Type II dominant on lip print. In this study, Pearson chi-square showed a significant statistical difference in lip print patterns between male and female subjects with a significant value  $p < 0.001$ . Pearson chi-square test indicated that there was no significant difference in lip print pattern between races where  $p > 0.05$ .

TABLE 2. Types of lip print between sexes and races

Sex	Types of lip print						Chi-square test p
	I	I'	II	III	IV	V	
Male	21	11	4	26	3	2	0.000
Female	29	29	0	6	2	1	
Malay	24	31	2	23	5	3	0.086
Chinese	18	9	2	7	0	0	
Indian	8	0	0	2	0	0	

Table 3 showed individual with dominant type II, III and IV grooves could be categorized as male with the accuracy of 41.4% to 77.8%. Individual with dominant type I, I' and V grooves could be categorized as female with the accuracy of 76.9% to 92.9%. Overall the accuracy for sex determination was almost 63.6% to 77.3%.

TABLE 3. Category of sex by using lip print

Deviation Point	Category	Accuracy (%)	Overall of Accuracy (%)
II, III, IV	Male	41.4 – 77.8	63.6 – 77.3
I, I', V	Female	76.9 – 92.9	

Forty lip print samples were taken to validate the method in individualizing lip prints into sexes manually. The accuracy table (Table 4) was made to show the accuracy of the method of in estimating the lip prints according to gender. Eighteen out of twenty females had been correctly identified with the precision percentage of 90%. However, for males, only 13 out of 20 subjects had been correctly identified and the percentage of accuracy was 65%. Therefore, the percentage of in determining the lip print into males and females correctly was 77.5%.

TABLE 4. Accuracy table to validate method in categorizing lip print into sex

		Predicted	
		Male	Female
Actual	Male	13	7
	Female	2	18

Table 5 showed width of oral opening and height of lower lip could be used for sex determination. Width of oral opening of more than 50.20 mm could be safely categorized an individual as male with accuracy of 74.2% to 81.8% while width of oral opening less than 50.20 mm could be safely proved an individual as female with accuracy of 62.1% to 71.4%. Any measurement of less than 10.83 mm for height of the lower lip could point to a female while more than 10.83 mm could say it was a male with overall accuracy of 60.3% to 76.6%.

TABLE 5. Category of sex by using lip measurement

Type of measurement	Deviation Point	Category	Accuracy (%)	Overall of Accuracy (%)
Width of oral opening	≤ 50.20	Female	74.2 – 81.8	70.4 – 76.2
	> 50.20	Male	62.1 – 71.4	
Height of lower lip	≤ 10.83	Female	55.9 – 100.0	60.3 – 76.6
	> 10.83	Male	60.0 – 81.8	

Table 6 showed race determination using height of upper lip and lower lip. The Malays usually has less than 8.24 mm for height of upper lips while the Chinese were the opposite. Overall accuracy was 45.5% to 70.5%. Height of the lower lips was longer in the Malays (more than 10.41 mm) in contrast to the Chinese. Overall accuracy was almost as same as the measurement using the height of upper lip (47.4% to 75.0%).

TABLE 6. Category of race by using lip measurement

Type of measurement	Deviation Point	Category	Accuracy (%)	Overall of Accuracy (%)
Height of upper lip	≤ 8.24	Malay	81.0 – 83.3	45.5 – 70.5
	> 8.24	Chinese	21.4 – 52.9	
Height of lower lip	≤ 10.41	Chinese	33.3 – 52.9	47.4 – 75.0
	> 10.41	Malay	61.8 – 88.9	

In summary, width of oral opening and height of lower lip between sexes showed significant difference ( $p < 0.001$ ). Height of upper lip and lower lip displayed significant differences ( $p < 0.05$ ) between races. Two-way repeated measurement ANOVA did not show any

significant difference in all the three lip measurements for the interaction of sex and race. With these results, each lip print found at the crime scene could be identified based on sex and race (Malay and Chinese).

## DISCUSSION

Lip print is a combination of more than one type of groove (Jaishankar et al. 2010). Lipstick-cellophane tape method was used in lifting the lip print, because of the lipstick-paper-cardboard description by Bindal et al. (2009) could not produce clear lip print. However, the former method improves the visualization of the lip print Verghese et al. (2010).

The results showed that there was a significant difference in lip print between males and females, which supported the findings of Sharma et al. (2009), Sonal et al. (2005) and Gondivkar et al. (2009). Therefore, lip print is a reliable method in determining the sex of the individual. According to Sonal et al. (2005), certain pattern trend of lip print were prevalent in either male or female. However, the finding of the present study is contradictory to the previous reports in which both males and females were having same type of groove that were dominantly present in their lip prints (Augustine et al. 2008; Bindal et al. 2009; Saraswathi et al. 2009; Verghese 2005; Verghese et al. 2010). The different results obtained in the present study could be explained by the differences in the subject population taken (Verghese 2005). Although Augustine et al. (2008) stated that a minimum number of type V patterns were observed and there was complete coverage of patterns in Tsuchihashi classification, however in the present study, there was no female having groove type II dominant on lip print. Thus, the sample size should be increased in order to achieve a complete coverage of sample in this study.

Although the sex and the race can be determined by using lip measurement or lip print, the percentage of accuracy and the performance evaluation were not high. Besides, statistical tests showed that there was no relationship between sex and race in lip measurements. Therefore, it cannot be used to categorize lip measurements both for sex and race.

Smudging of lip prints was found mainly in males' lip prints especially on the upper compartments. It was probably due to the prominent facial hair or moustache on male subjects as reported by Saraswathi (2009). Gondivkar (2009) stated that lip print on the transition zone was extremely mobile and most probable changes in shape often, pressure and the direction during the lifting process, thus, resulted in misinterpretation. However, type I was not as same as type II groove. Each type of groove had its own identity.

The findings in present study may have been influenced by the error while measuring the lip. Jaishankar et al. (2010) stated that subjects have to relax without



stretching their lips during the process of lip measuring. Lip measurements can be inconsistent when the subject does not close it properly and relaxes it. Therefore, in this study, each measurement was repeated three times and the mean of the measurement was used for analysis.

The present study showed that lip print had a potential in sex and race determination. The measurement on the lip prints was different with the measurement taken from the lip directly. The percentage of accuracy in determining males was not as high as in females. It was because when the lip print configuration was done, it was difficult to define whether it was male or female. Therefore, it may be explained by the trend in both of the males and females having same prevalence at a same time. Lip print is different from fingerprint and ear print. All three are the approved physical evidence in individual identification and are equally important. Each of them can indicate different events that occurred before the crime. Besides, lip print analyses do not require any complex instruments. Therefore, it is easier to be conducted and analyzed.

## CONCLUSION

The lip measurements can be used to determine the sex or race of a person however the percentage of accuracy generated by Classification Tree for each measurement was not high. Further work on the subject and maximize the number of subject involves in the study can help to make cheiloscopy a practical reality at the ground level of the forensic identification process.

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